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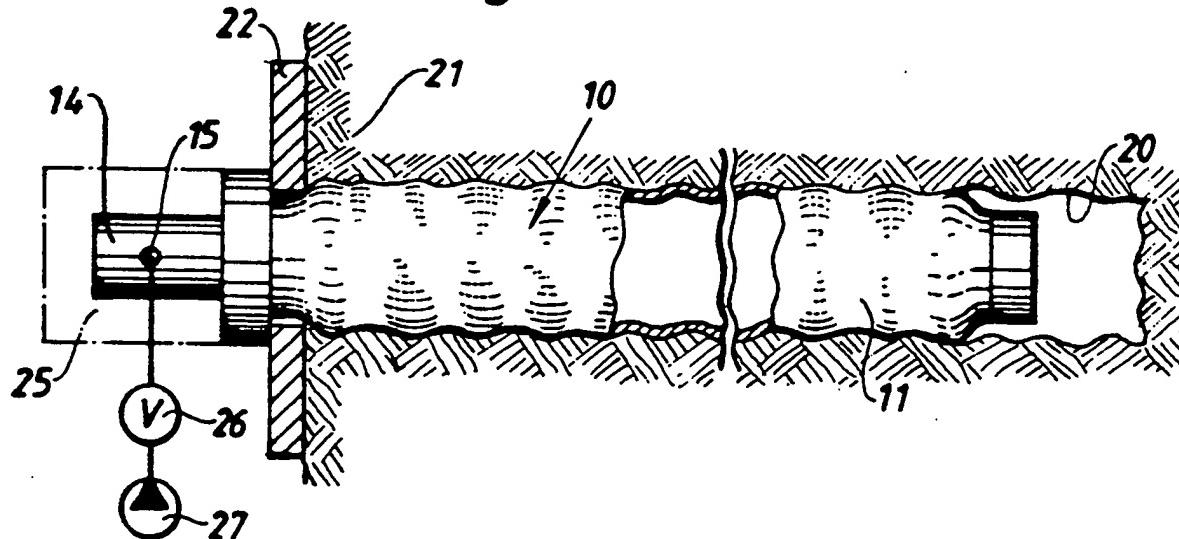
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(54) Method of stabilizing a rock structure and stabilizer therefor.

(57) A closed tubular preferably circular cylindrical rock stabilizer is made of expansible mild steel and given a perimeter equal to  $\pi D$ . After being inserted in a drill hole of a diameter slightly larger than D, the stabilizer is expanded radially by hydraulic high pressure fluid past the value D to such an extent that the irregularities of the drill hole are filled and the rock widened elastically around the stabilizer to provide an anchoring shrinkage fit therefor.

Fig. 3



## Method of stabilizing a rock structure and stabilizer therefor

This invention relates to a method of stabilizing a rock structure and a stabilizer adapted for performing the method.

In US patent 4.423 986 a rock stabilizer is shown which comprises a closed longitudinally folded tube which is pressurized to expand to anchor in the borehole. This bolt provides an outstanding anchoring and the accepted diameter range of the holes is extremely wide. However, the bolt is comparatively expensive.

In the Swedish patent specification 8502981-7 a tubular rock stabilizer is shown which is expanded past the size of the drillhole by means of an expansible body inserted into the stabilizer. Thereby the stabilizer is anchored in the drillhole by elastic compression of the rock surrounding the stabilizer. This allows the use of cheap stabilizers but the expansible body has a limited operational life due to the necessary high pressure.

In US patent 3 349 567, a rock stabilizer is shown which comprises a tube to be inserted in the borehole and then expanded at discrete points by pulsed magnetic fields induced by high voltage pulses in a coil on a probe that is temporarily inserted in the stabilizer. The stabilizer is cheap but the necessary equipment very expensive and there are considerable safety hazards due to the high voltage.

It is an object of the invention to provide an efficient method of stabilizing a rock structure enabling the use of simple stabilizers which together with the method provide a low total cost for stabilizers as anchored in the rock.

The invention will be described with reference to the drawings.

Fig 1 is a longitudinal section of a bolt inserted in a drill hole prior to expansion.

Fig 2 is a section on the line 2-2 in Fig 1.

Fig 3 shows the bolt in Fig 1 after anchoring by radial expansion.

Fig 4 shows an alternative outer end portion for the stabilizer in Fig 1.

Fig 5 shows an expansible stabilizer section intended for an extension build-up of stabilizers provided by one or more interconnected such sections, and outwardly terminated by the end portion of Fig 4.

Fig 6 is a closure plug for the bottom end portion of such an extension build-up.

Fig 7 is a non-expansible stabilizer section providing an alternative for one or more extension section according to Fig 5.

The rock stabilizer 10 or roof bolt shown in Fig 1 comprises a closed elongated straight cylindrical tube 11 of steel of a property providing uniform

elongation under expansive load. A suitable steel given as an example is the deep drawing quality steel Swedish standard SS 141147. If the outer diameter of the tube 11 is designated D cm, its perimeter would be  $\pi D$  cm. Unchanged in perimeter the tube may have a slightly welded or somewhat irregular cross-section for increased stiffness. The bottom end of the tube 11 is closed tightly by a circular plate 12 welded to the tube 11 preferably by friction welding. To the outer end is similarly tightly connected a flange 13 with an outwardly protruding cylindrical boss 14. An inlet 15 of a passage 16 to the interior of tube 11 is provided on the boss 14.

5 The stabilizer 10 is freely inserted into a drill-hole 20 drilled in a rock structure 21 with a diameter somewhat larger than D cm. While inserted, the stabilizer 10 by its flange 13 keeps a supporting plate 22 which surrounds the tube 11, resting against the rock 21.

10 Before or after insertion a diagrammatically indicated chuck 25, preferably of the type shown in US patent 4 423 986, Figs 1, 10, is slipped and tightly set onto boss 14 and the opening 15 is supplied under pressure control of a valve 26 by hydraulic high pressure fluid under a pressure of up to 500 bar from a pump 27. This pressurizes the interior of the stabilizer 10 causing a radial expansion thereof which fills the normal always present irregularities of the drillhole and widens the surrounding rock elastically as depicted in Fig 3. The pressure is then relieved and the chuck 25 removed so that the stabilizer eventually is emptied of fluid. Although some shrinking may take place at relief, the stabilizer remains firmly anchored in the drillhole 20 due to the significantly larger shrinkage fit of the rock 21 around the expanded stabilizer 10. A suitable manometer or other instrument in the hydraulic supply may be used for increased control during the radial hydraulic expansion of the stabilizer 10.

15 As an alternative the stabilizer 10 may be provided instead of the boss 14 with a coupling nipple 28 of the type shown in Fig 4. In such case a quick release coupling may be used for the hydraulic high pressure fluid supply.

20 In order to match long drillholes by short lengths of expansible stabilizers of the type in question, extensible expansible tubular stabilizer sections 30 according to Fig 5 may be used, at will combined with non-expansible (narrow channel 36) sections 31 of the type shown in Fig 7, both sections 30,31 having respectively male and female coupling means 34,35 for tight interconnection of their ends. A head 32 with a coupling means

formed by a threaded hole 33, Fig 4, provides the outer end of the extended stabilizer, to which for example one or more non-expandable sections 31 can be tightly connected as by threaded coupling means 34,35 and terminated within the drillhole by one or more expandible sections 30 coupled thereto, the last of them closed by a threaded plug 38, Fig 6.

## Claims

1. A method of stabilizing a rock structure comprising providing an elongated expandible closed tubular stabilizer of mild steel and a perimeter equal to  $\pi D$ , drilling a hole in the rock of a diameter somewhat larger than D to permit the tubular stabilizer to be freely inserted in the drillhole, inserting the stabilizer in the drillhole with one of its ends, the bottom end first, coupling the other outer end of said stabilizer to an external source of hydraulic high pressure fluid, pressurizing the stabilizer by a controlled supply of hydraulic high pressure fluid to such an extent that the stabilizer is widened past the amount D by radial expansion thereby filling the irregularities of the drillhole and widening the rock elastically therearound, whereafter the stabilizer is relieved of pressure, emptied and left anchored in the drillhole by the shrinkage fit between the rock and the stabilizer.

2. The method according to claim 1 wherein the stabilizer is provided with a circular cross section.

3. The method of claim 2 wherein the stabilizer is expanded to anchor in the borehole over substantially the entire length of the stabilizer.

4. The method of claim 1 wherein the stabilizer is extended to match long drillholes by interconnecting for hydraulic communication the bottom and outer ends of a sufficient number of adjacent stabilizers.

5. The method of claim 4 wherein the stabilizer is extended by non-expandible stabilizer sections.

6. A tubular rock stabilizer to be anchored by the method according to claim 1 in a drillhole drilled in a rock structure, comprising a closed elongated tubular body of mild expandible steel having a perimeter equal to  $\pi D$  dimensioned to be freely insertable into a drillhole of a diameter somewhat larger than D, the stabilizer being closed at one end which is the bottom end thereof, an open inlet at the outer end portion of said stabilizer opposite said bottom, and means removably connectable to said inlet for controllably supplying hydraulic high pressure fluid via said inlet to the interior of said stabilizer sufficiently to widen said stabilizer by radial expansion substantially past the perimeter value  $\pi D$ .

7. The stabilizer of claim 6 wherein said stabilizer is circular in cross section and expandible over substantially the entire length thereof.

8. The stabilizer of claim 6 wherein said outer end portion is a cylindrical boss and said inlet is disposed on the periphery of said boss.

9. The stabilizer of claim 6 wherein the ends of the stabilizer provide male and female coupling means, respectively, thereby to enable stabilizer extension by intercoupling of two or more identical stabilizer sections.

10. The stabilizer of claim 9 wherein the stabilizer is extended by one or more non-expandible stabilizer sections.

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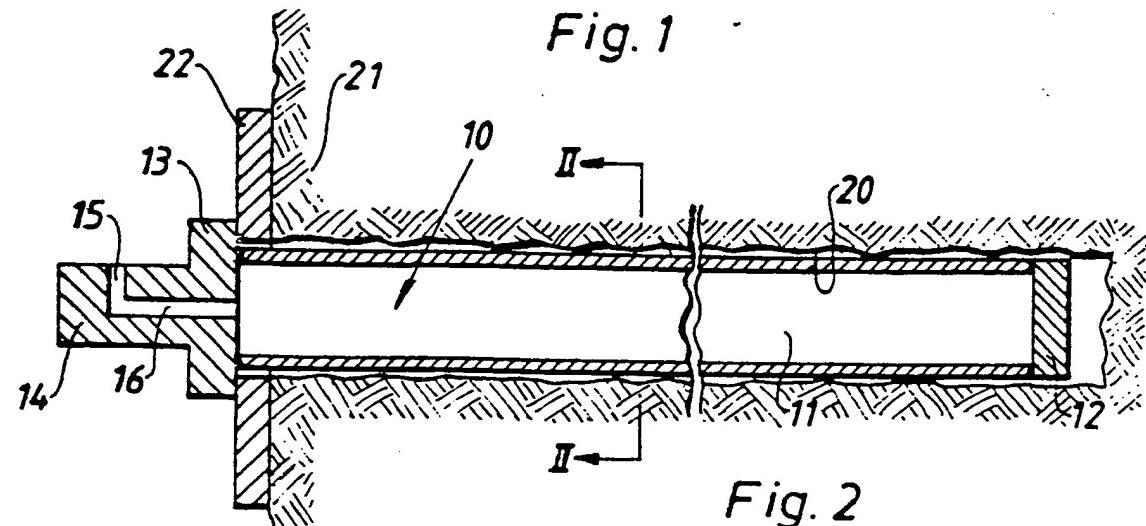
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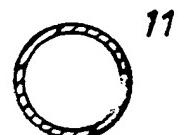
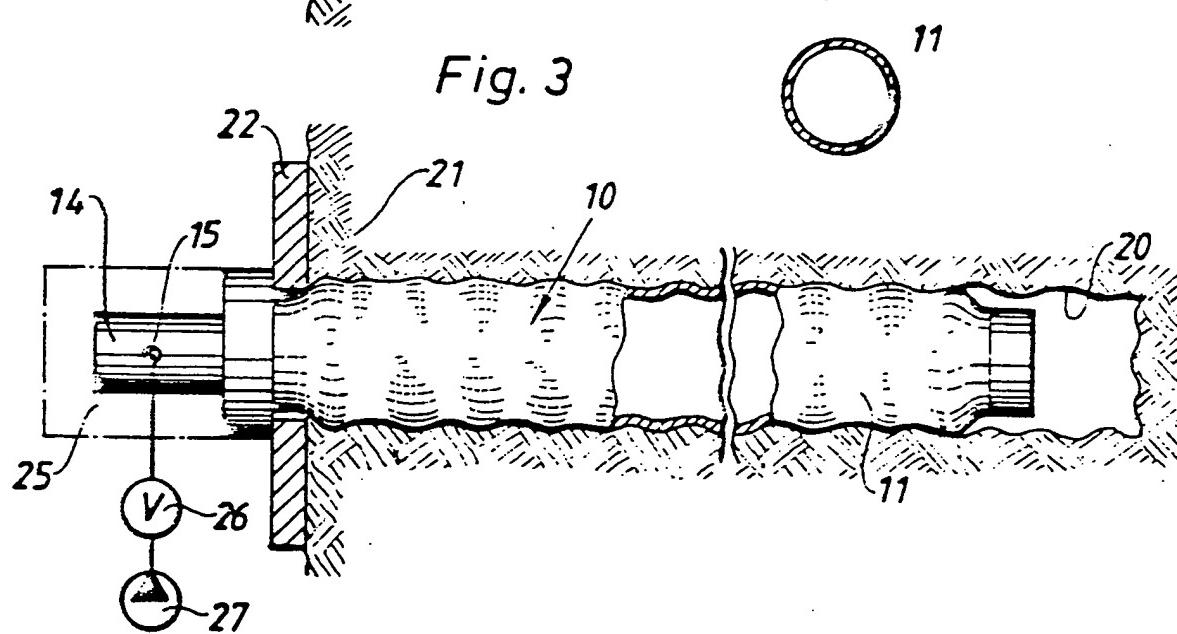
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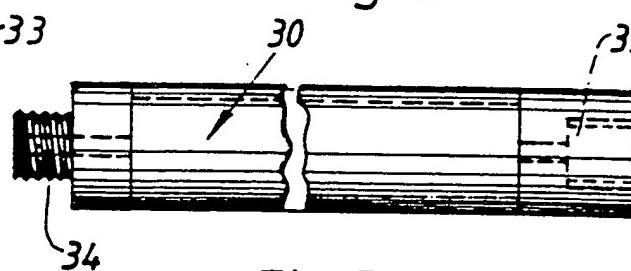
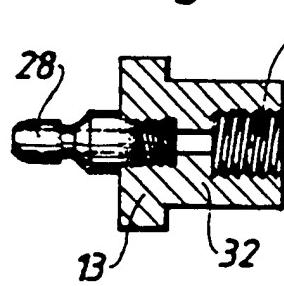
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*Fig. 2*



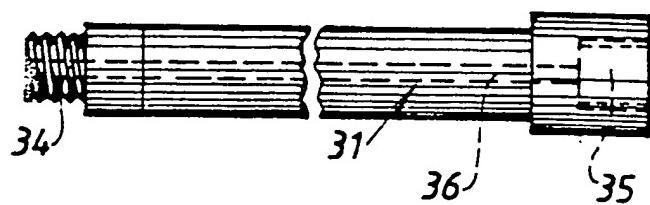
*Fig. 4*



*Fig. 6*



*Fig. 7*





EP 87 85 0353

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. CL 4)
P, A	EP-A-0 207 030 (ATLAS COPCO) ---		E 21 D 21/00
A, D	US-A-3 349 567 (MUNN) ---		
A, D	US-A-4 423 986 (SKOKBERG) ---	1	
A	US-A-4 098 087 (SWAIN) * abstract * -----		
TECHNICAL FIELDS SEARCHED (Int. CL 4)			
E 21 D 21/00 E 21 D 20/02			
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
BERLIN	25-01-1988	ZAPP E	
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document	
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